Session 242 - Visual Learning, Memory, and Categorization

Add To Itinerary

242.03 / NN4 - Visual perceptual learning and visual cortical plasticity in monkeys caused by VTA microstimulation in the absence of attention.

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Presenter at Poster
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Poster

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J.T. Arsenault: None. **W. Vanduffel:** None.

Abstract
Visual perceptual learning (VPL) is influenced by the interaction of attention and reinforcement. Interestingly, VPL can occur in absence of stimulus-directed attention (Seitz et al., 2009). Such task-irrelevant perceptual learning (TIPL) has been hypothesized to result from the temporal coincidence of a stimulus and neuromodulatory signals triggered by reinforcement. Consequently, TIPL offers an opportunity to isolate the role of neuromodulatory signals in the regulation of VPL and plasticity while excluding the role of attention. Although several neuromodulatory centers may be involved in VPL, the ventral tegmental area (VTA) is a good candidate because its neurons are activated by reinforcement, have widespread connections and release dopamine that facilitates plasticity. Therefore, we microstimulated monkey VTA (VTA-EM) to determine its causal role in VPL and cortical plasticity.
In Exp 1 we looked for plasticity. To do this we performed fMRI mapping (pre-association) to determine the response to 4 different grating stimuli [(L/R visual field) x (45°/135°)]. During all phases, the animals performed a difficult, orthogonal color discrimination task (80% correct performance) during grating presentation to avoid grating-directed attention. Next came a cue-VTA-EM association phase in which all gratings were shown but one was temporally associated with VTA-EM (20 sessions). Again, the color task was used to control attention. Finally, post-association fMRI mapping was identical to phase 1. The analysis demonstrated representation-specific enhancements (post vs. pre) in fMRI activity for the stimulated grating orientation within the 'trained' visual field, especially pronounced in PIT. These changes were not found for gratings displayed in the 'untrained' visual field.
In Exp 2 we looked for VPL effects. Exp 2 also consisted of pre- and post-association phases bookending a cue-VTA-EM association phase (6 - 20 sessions). Within the pre- and post-association phases the animals discriminated between upward and downward random dot motion stimuli presented in the left or right visual field at 6 motion coherences (0 - 50%). The cue-VTA-EM association phase consisted of bilateral presentations of 0 and 2% motion stimuli with only one 2% coherence stimulus being associated with VTA-EM. The color task was again used to avoid directed attention to the motion stimuli. Enhanced performance for lower motion coherences (2 - 12%) were consistently observed in the test phase for the 'trained' visual field. These results provide causal evidence for the role of primate VTA in VPL and stimulus-specific plasticity in the absence of stimulus-oriented attention.